

WHAT IS CLAIMED IS:

1. A system for source routing in an ad hoc network, the system comprising:
  - a route discovery mechanism that propagates link quality information;
  - a route maintenance mechanism that detects a transmission failure and determines whether a link quality metric for a link should be penalized;
  - a link quality metric maintenance mechanism; and
  - a mechanism for calculating routes based on link quality metrics.
2. The system of claim 1 wherein the link quality metric maintenance mechanism comprises:
  - a reactive metric maintenance mechanism that maintains metrics for links that a node is actively using to route packets; and
  - a proactive metric maintenance mechanism that maintains metrics of all links.
3. The system of claim 1 wherein the system resides in a virtual protocol interlayer.

4. The system of claim 3 wherein the virtual protocol interlayer comprises layer 2.5 of a network protocol stack.
5. The system of claim 1 wherein the system exposes a virtual Ethernet network adapter to higher layers of a network protocol stack.
6. The system of claim 5 wherein the system demultiplexes a plurality of physical network adapters.
7. The system of claim 1 wherein the system resides in a data link layer of a network protocol stack.
8. The system of claim 1 wherein the system resides in a network layer of a network protocol stack.
9. A system for link-state source routing in an ad hoc network, the system comprising:
  - a send buffer that holds packets while route discovery is performed;
  - a maintenance buffer that is used for route maintenance;

a request table that suppresses duplicate route discovery requests; and  
at least one link quality metric module that determines quality of links  
to neighboring nodes.

10. The system of claim 9, further comprising a link cache.
11. The system of claim 9, further comprising a route cache that stores link quality metric information.
12. The system of claim 9 wherein the at least one link quality metric module uses a probing technique.
13. The system of claim 12 wherein the at least one link quality metric module comprises one or more of a per-hop round-trip time metric module, a per-hop packet pair delay metric module, and an expected transmission count metric module.
14. The system of claim 9 wherein the at least one link quality metric module determines quality of links based on received signal strength information.

15. The system of claim 9 wherein the at least one link quality metric module determines quality of links based on a sender's IEEE 802.11 retransmission counts.

16. In a multi-hop ad hoc network, a method for discovery of a route from a first node to a target node, the method comprising:

- broadcasting, by the first node, a route request message;
- receiving, by a neighboring node, the route request;
- appending, by the neighboring node, an address of the neighboring node to a path listed in the route request, and adding a link quality measurement;
- rebroadcasting, by the neighboring node, the route request;
- receiving, by the target node, the route request; and
- sending, by the target node, a route reply message to the first node,

wherein the route reply includes a complete list of link quality measurements for links comprising the route from the first node to the target node.

17. The method of claim 16 wherein the sending the route reply to the first node is by way of an independently-discovered source route from the target node to the first node.

18. The method of claim 16 wherein the link quality measurement is based on a probing technique.

19. The method of claim 18 wherein the link quality measurement is based on one of a per-hop round-trip time metric, a per-hop packet pair delay metric, and an expected transmission count metric.

20. The method of claim 16 wherein the link quality measurement is based on received signal strength information.

21. The method of claim 16 wherein the link quality measurement is based on a sender's IEEE 802.11 retransmission counts.

22. In a multi-hop ad hoc network, a method for forwarding a data packet from a source node to a destination node by way of a source route listed in the data packet, the method comprising:

by a forwarding node, modifying the source route with one or more updated link quality measurements; and

by the destination node, updating the destination node's link cache with link quality information for the source route.

23. The method of claim 22 wherein the one or more updated link quality measurements are based on a probing technique.

24. The method of claim 23 wherein the one or more updated link quality measurements are based on one of a per-hop round-trip time metric, a per-hop packet pair delay metric, and an expected transmission count metric.

25. The method of claim 22 wherein the one or more updated link quality measurements are based on received signal strength information.

26. The method of claim 22 wherein the one or more updated link quality measurements are based on a sender's IEEE 802.11 retransmission counts.

27. In a multi-hop ad hoc network, a route maintenance method for a source routing protocol, the method comprising:
- determining, by a forwarding node sending a packet to a neighboring node over a next link in a source route for the packet, whether the link fails to carry the packet; and
  - if the link fails to carry the packet, penalizing a link quality metric associated with the next link.
28. The method of claim 27, further comprising sending a route error message carrying the penalized link quality metric to a source of the packet.
29. The method of claim 27 wherein the penalizing the link quality metric comprises increasing a value for the link quality metric by a percentage.
30. The method of claim 27 wherein the determining whether the link fails to carry the packet comprises detecting that an explicit acknowledgement message has not been received from the neighboring node within a time interval.

31. A computer-implemented method for sending a packet by a node in a multi-hop ad hoc network in accordance with a source routing protocol, the method comprising:

if the packet is not a unicast packet, using a route request message including link quality information to broadcast the packet;

if the packet is a unicast packet and a source route for the packet is stored in a link cache,

placing the packet in a maintenance buffer;

adding the source route, including link quality information, to the packet; and

sending the packet to a next hop in the source route;

if the packet is a unicast packet and the source route is not stored in the link cache,

placing the packet in a send buffer; and

sending a route request to discover the source route.

32. The method of claim 31, further comprising:

adding a layer 2.5 header to the packet.



33. The method of claim 31 wherein sending the packet to the next hop comprises:

if a layer 2 address for the next hop is stored in a neighbor cache,  
sending the packet to the layer 2 address; and

otherwise, sending the packet by way of a layer 2 broadcast.

34. A computer-readable medium storing computer-executable instructions for performing the method of claim 31.

35. A computer-implemented method for receiving a packet by a node in a multi-hop ad hoc network in accordance with a source routing protocol, the method comprising:

updating a link cache with link quality information contained in the packet;

if the packet is a route request, and the node is a target of the route request, sending a route reply, including link quality information;

if the packet is a route request, and the node is not the target,  
determining whether the route request is a duplicate of a request in a request table;

if the route request is a duplicate, suppressing the route request;

if the route request is not a duplicate,

adding the route request to the request table;

adding link quality information to the route request; and

rebroadcasting the route request;

if the packet is a source routed packet, and the node is not a final destination of the packet,

updating the source route with link quality information; and

using a maintenance buffer to forward the packet.

36. A computer-readable medium storing computer-executable instructions for performing the method of claim 35.

37. In a multi-hop ad hoc network, a method for maintaining link quality metrics in accordance with a source routing protocol, the method comprising:

reactively maintaining link quality metrics for a source route of a packet; and

proactively maintaining link quality metrics for all links.

38. The method of claim 37 wherein the reactively maintaining link quality metrics comprises:

by a forwarding node, updating the source route with a current link quality metric for a next link in the source route; and

by a destination node, sending a gratuitous route reply message to a source node of the packet, wherein the gratuitous route reply contains link quality metrics for the source route.

39. The method of claim 38 wherein the sending the gratuitous route reply message comprises:

delaying the sending for a time interval while the destination node waits for an opportunity to piggyback the gratuitous route reply; and

while delaying the sending, updating the link quality metrics for the source route when an additional packet arrives from the source node.

40. The method of claim 37 wherein the proactively maintaining link quality metrics comprises:

by each node in the network, periodically broadcasting a link information message that carries current link quality metrics for each link from the node.

41. The method of claim 40 wherein the broadcasting the link information message comprises piggybacking the link information message on a route request.

42. The method of claim 40 wherein the broadcasting the link information message comprises generating a dummy route request to carry the link information message.